ORGAN BUILDING

FOR

AMATEURS

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A

Practical Guide for Home-Workers

CONTAINING SPECIFICATIONS, DESIGNS, AND FULL INSTRUCTIONS FOR MAKING EVERY PORTION OF THE INSTRUMENT.

BY

MARK WICKS

WITH OVER TWO HUNDRED ILLUSTRATIONS AND EXPLANATORY DIAGRAMS.

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PREFACE.

IN submitting this little work to the public I must, in the first instance, warn the reader that it is not written with the intention of dealing exhaustively with organ building generally, but, as its title implies, only with that particular phase which comes within the means and scope of an intelligent amateur workman. Therefore, such refinements as electric and pneumatic actions, not being required in small instruments, find no place in this work, but everything of interest to a home-worker is touched upon in a thoroughly practical manner.

There are many works on the subject to which builders, purchasers, or general readers may resort for information respecting organs, but the instructions contained in most of these works being limited to general, and often vague, description, are of little service to an ordinary amateur desirous of building the instrument himself; as in most cases the idea of building an organ at home is taken up by persons having little knowledge of the construction of the instrument which they so ardently desire to possess. It is indeed rather surprising that there is not a larger supply of literature dealing with this subject from an amateur's point of view, for it is a matter which is constantly claiming the attention of young men of mechanical proclivities, and also one which exercises an astonishing and peculiar fascination over them. But beyond isolated papers in magazines and the little manual of the Rev. W. E. Dickson, there does not appear to be anything which can rightly be considered as meeting the requirements of persons of the class referred to. It is with the object of supplying this want that I have been induced to compile the little manual which now seeks the suffrages of home-workers. As an amateur organ-builder I may fairly claim to have some knowledge of the necessities of that class, and of the difficulties which beset them

at every turn. It has been my endeavour to smooth away those difficulties by describing every part of the instrument in the fullest detail, and by supplementing the instructions, wherever practicable, with carefully drawn illustrations.

The method of making pipes of paper, which is an invention of my own, will, I trust, prove a boon to amateurs, especially those of limited means, as by making pipes of this material the most expensive item in the cost of the instrument is reduced to a comparatively nominal sum. I do not think I could adduce better testimony of their efficiency than the fact that a practical organ-builder, who is quite unknown to me, has thought it worth his while to take up the manufacture of these pipes, and to enlarge his workshops for the purpose.

I would add that the care, patience, and perseverance devoted to building even a small organ at home necessarily afford most valuable training to young men, and the moral value of the instrument itself in a home where children are growing up cannot, I think, be overestimated.

July, 1887.

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ORGAN BUILDING FOR AMATEURS

CHAPTER I.

TOOLS AND APPLIANCES – SPECIFICATIONS – NEW METHOD OF MAKING PIPES.

THERE are few things that possess more fascination for the amateur mechanic than a musical instrument, and few, indeed, that, if the work be well carried out, will so fully reward him for his patience and labour. The organ, that acknowledged king among keyed instruments, is of such construction that every portion of it may be made by a person possessing a little skill and a fair amount of patience and ingenuity. In this respect it differs from the piano or harmonium, as in those instruments the really music producing portions would not be placed to the credit of the amateur, but would necessarily be purchased, whereas every pipe in the organ could be made by the amateur himself.

Before proceeding with the instructions for the building of the instrument it will doubtless be well that I should indicate the principal appliances and tools required for the work.

First and foremost, a good, firm, and level bench is absolutely necessary, and this should be at least 6 feet long, or capable of being extended to that length by means of an end flap with firm supports. It must also be provided with the usual appliances for holding the wood firmly whilst it is being planed, etc.

We shall require one or two hand-saws for ripping planks and for general sawing work, and also one large and one small tenon saw.

Of planes we must have at least three, viz. —a jack-plane for rough work, a trying-plane for planks and for shooting joints, and a smoothing-plane for finishing off. In addition to these one or two small American iron planes would be found very useful.

A tool commonly known as an "old woman's tooth," or router, will also be necessary for clearing out and levelling groovings.

At least four chisels, viz. : $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{5}{8}$ inch, and $1\frac{1}{4}$ inch. One or two of the intermediate sizes and a $\frac{3}{8}$ inch mortise chisel would be very handy, but are not absolutely necessary.

A gouge or two, say $\frac{1}{2}$ inch and $\frac{3}{4}$ inch, for making conducting grooves, etc.

A hammer and mallet and a marking gauge are, of course, indispensable.

A good brace and set of at least six bits of different sizes, ranging from $\frac{3}{16}$ inch up to $1\frac{1}{4}$ inch will be needed, and an expanding bit would be an acquisition. These bits may be either American twist bits, or the ordinary nosed centre -bits.

A small Archimedean drill, with three or-four drill-bits of various sizes.

Three or four gimlets and bradawls of different sizes.

A screwdriver, and two or three files of different shapes and degrees of fineness.

A glue-pot holding at least a pint of glue, and two or three glue brushes of-various sizes.

Two or three paint brushes, one very small and the others medium-sized sash tools.

A wood **T**-square, not less than 30 inches long, a metal-bladed carpenter's square, 9 or 12 inches

A few screw cramps.

A soldering iron for metal work, if it is intended to do this work at home.

A pair of cutting pliers, and also a pair of round nosed pliers of small size, for wire work.

A few other special tools may be required, which will be described when dealing with the work.

Of course, it will be understood that these tools need not all be purchased before commencing the work, but only such as are needed for the operations actually in hand. The others can be acquired as the progress of the work calls for their aid. It is, however, absolutely necessary that all tools should be of good quality and always kept in thorough order, for it is impossible to work well with bad or blunt tools.

As regards skill in workmanship, if the would-be organ-builder can plane a board true, make a good joint (such as a butt joint, dovetail or mortise and tenon), and possesses a general knowledge of the use of the various tools mentioned herein, he can, with patience and perseverance, accomplish nearly all that is set out in these pages.

All wood used must be of the best quality, thoroughly sound, well-seasoned, and free from knots and shakes.

It should be purchased and kept in a warm dry place, as long possible before using.

The leather used in organ building is white sheep-skin, specially prepared for the purpose, and *no other kind* will be suitable. It can be procured at any shop where organ requisites are sold, and generally costs about 3*s.* or 3*s.* 6*d.* a skin. Shoemaker's white leather will be of no service whatever.

I now propose to give such instructions as will enable amateurs to build themselves a really useful instrument, that may be a source of pleasure to themselves and their friends for many years to come. In order to meet the requirements of all, and with the view of making

the instructions as intelligible as possible, I shall describe a specific instrument, and add such information as may be requisite to enable the amateur to build either a smaller or a larger one, as the length of his purse may permit. But I would here urge upon all intending workers that, whatever scheme they may adopt, they should keep to, and work away at it steadily until all is completed, for many commence upon work which they have not sufficient patience to carry out, and consequently, they never have anything to show for the time and money which they have expended.

Amateurs should also consider the time and means at their disposal, before deciding on the work, and will do well to remember that a very small organ, if built in spare time, after ordinary working hours, may require months, or even years of patient application before the work can he completed. The greatest pains should be taken in the construction of every part, and all should be done as though one's life depended on the result.

The specification for the instrument to be described is as follows :–

1. Open Diapason to Tenor C	44 pipes.	8 feet tone.
2. Stopt Diapason, Bass	12 "	8 "
3. Stopt Diapason, Treble	44 "	8 "
4. Flute (for Principal)	56 "	4 "
5. Keraulophon (small scale, to Tenor C)	44 "	8 "
6. Flageolet (for Fifteenth)	56 "	2 "
7. Bourdon (pedals)	25 "	16 "
Total	281 pipes.	

Couplers : octave ; great to pedal.

The whole may be enclosed in a general swell. Size about 6 feet 6 inches wide, 9 feet high, and 3 feet deep.

There will be room for another stop of twelve pipes in the bass, which may be utilised at any time by the insertion of a stop of the violoncello type.

If the Bourdon were omitted it would reduce the size of the instrument considerably, or a nice little instrument could be made by having the first four or five stops only.

For a small two-manual instrument, the following would be a good specification :—

Great organ :—		
1. Open Diapason to Tenor C	44 pipes.	8 feet tone.
2. Stopt Diapason, Bass	12 "	8 "
3. Principal (Flute)	56 "	4 "
4. Flageolet	56 "	2 "
Swell organ :—		
5. Lieblich Gedacht	56 "	8 "
6. Keraulophon to Tenor C	44 "	8 "
Pedal organ :—		
7. Bourdon	25 "	16 "
Total	293 pipes.	

Couplers : swell to great unison ; swell to great octave ; great to pedal.

Same size as No. 1, but 6 inches deeper.

A smaller two-manual might comprise the following stops :— Great organ

Great organ :—		
1. Open Diapason to Tenor C	44 pipes.	8 feet tone.
2. Stopt Diapason, Bass	12 "	8 "
Swell organ :—		
3. Lieblich Gedacht	56 "	8 "
4. Flute (or Principal, small scale)	44 "	4 "

Couplers : swell to great unison ; swell to great octave ; octave on great.

The pedal-Bourdon may, or may not, be added, according to the will of the amateur. If it is, a coupler, great to pedals, would be needed.

NOTE.—If octave couplers are attached to any of these organs, they will be made much more efficient by carrying each stop on which they act an octave higher in the treble, so that *every* note in the compass of the key-board will be connected with one an octave higher when the octave coupler is in action.

The intending organ-builder has thus several schemes to choose from ; and, as the dimensions of the soundboard and all other portions will be fully set out in the succeeding articles, he will be enabled to find all the dimensions he will require. The scales for the pipes will be the same for each organ.

It will be noticed that in neither of the above specifications have I mentioned the materials of which the pipes are to be made, and my reason for not doing so is, that I have worked out a new method of making them, and now propose to give the amateur the benefit of my experience. Many who would much like to build an organ are deterred from doing so by the great outlay necessary to purchase the pipes, or the materials for making them ; but it is now open to anyone, by following my instructions, to make the whole of the pipes required for Scheme 1, for a very much smaller sum than would be required to purchase the open Diapason alone. That stop, in metal, would cost about £5 to purchase, a wood stopt Diapason, £8 15*s.* ; a Bourdon, about £11 or £12 ; Principal, metal, £5 10*s.* ; Keraulophon, £6 ; Flageolet, £3 10*s.* ;—thus running up to something like £40 for the pipes alone. The cost of the materials for making these pipes would also be something considerable, whilst for pipes made on my system, about 10*s.* for each stop will cover the cost, and leave a margin. The Flageolet will cost less than 5*s.*

Many of my readers will no doubt smile incredulously when I state that the pipes are simply made of paper ; but I can only assure them that they answer thoroughly, and I have spent years in making various experiments for perfecting them. The idea, I believe, is not a new one, but I am not aware that it has ever before been practically worked out ; and, indeed, it was the ridicule cast on the plan by would-be scientists that induced me to persevere with it until I

succeeded. All pipes up to 2 feet long may be made of cartridge paper, but for longer pipes stout brown paper is the best.

The advantages I claim for my system are, that it is very cheap, far cheaper, in fact, than any system ordinarily followed, as the prices above quoted will show ; that the pipes are exceedingly light, a 4-foot stopt Diapason weighing about twenty ounces, or an open pipe the same size fourteen ounces, which will last very favourably with the weight of metal or wood in a similar pipe. They are easy to make, an amateur being more likely to succeed with these than with ordinary pipes, as they require but little skill, and no expensive tools ; and having, practically, no join throughout their length, there is no long glue joint, as in wood, or soldered joint, as in metal pipes, and, consequently, no risk of leakage. They take up only the same room as metal pipes, though they are much stronger, and cannot so easily be damaged by rough knocks, and any form of pipe can be made ; and last, but not least, you can try your pipes before completing them, and will thus be sure that they will answer.

Before starting on the pipes, set out the scale for them in the following manner :—on a nicely-planed board draw a line 4 feet 6 inches long, and at right angles to the top of this line draw another, $2\frac{5}{8}$ inches long, and join the end of the short line to the bottom of the long one by a sloping line ; 2 feet below the top line draw another thick line across from the long line to the sloping one, 1 foot below that draw another, 6 inches below that draw another cross line, and others at 3 inches, $1\frac{1}{2}$ inch, and $\frac{3}{4}$ inch, one below the other. Mark a **c** against each of these cross lines, and 6 inches from the bottom set off a thick line and mark it with the word "mouth." Now divide the spaces between each c into twelve equal parts ; the top one will thus be divided into twelve spaces of 2 inches each, the next one into spaces of 1 inch each, the next into spaces of $\frac{1}{2}$ inch each, and so on, each set being exactly half the size of the preceding one. Against each of these lines write the names of the notes in the same order as I have shown them in Fig. 1, but I have not been able to show them all through, as the scale is too small to admit of it. To find the size of any pipe, you measure from the line marked "mouth" up to the cross

line against which is name of the required note ; this gives you the speaking length of the pipe, and the length of the cross line is the interior diameter of it, and so you will proceed to find the size of any pipe you may require up 4 feet long.

Before proceeding farther, it may be as well that I should state that an open pipe 8 feet long, which sounds the note CC, is termed an "8-*feet tone*" pipe the same term is applied to the whole stop, not withstanding the fact that the stop may not extend down to CC on the instrument. Thus both the open diapason and the keraulophon are 8-feet stops, although cease at tenor C ; but if carried down to CC, the lowest note would require an open pipe 8 feet long. Closed, or stopt pipes, sound an octave lower than open ones ; so the stopt diapason, sounding CC with its pipe only 4 feet long, is still termed an 8-*feet tone stop*.

Four-feet tone stops, such as the principal, flutes, etc., sound an octave above the unison, or 8-feet toned stops, and their longest pipes on the manual sound-board are 4 feet long, unless they are what are termed *harmonic* stops, in which case, though the pipes give only the 4-feet tone, they require to be made as long as an ordinary pipe sounding the 8-feet tone.

Two-feet tone stops sound two octaves, or a *fifteenth*, above the unison stops.

Sixteen-feet tone stops, which appear on the pedal organ only, unless in a large instrument, sound an octave below the unison, and 32-*feet tone* stops sound two octaves below the unison ; but these latter stops are only found in instruments of the very largest size.

It will be noticed on setting out the scale, that each octave of pipes is roughly speaking, double the length of the succeeding octave. Thus all the pipes from CC to B, are double the length of those from tenor C to the B above. It will also be observed, that in the 4-feet octave, each pipe is 2 inches shorter than the preceding note, in the 2-feet octave, each pipe is 1 inch shorter than the one preceding it, and so on up to the smallest pipe.

It will be best for the amateur to make a small pipe or two, for experiment, before he starts on the set for the organ. A convenient size to commence with will be the G^2 in the treble of the open diapason. This pipe, as you will find from the scale, is $8\frac{1}{2}$ inches speaking length, and about $\frac{11}{16}$ inch diameter. You will require a mandrel to form it upon, and my method of making this is cheap and simple, viz., take a sheet of stout, smooth paper, 12 inches wide, and roil it up tightly until it is $\frac{11}{16}$ inch diameter (the size required for our pipe), taking care that you roll it straight, and have the ends square, or your pipe will not be a true cylinder, but slightly conical. When you have rolled it to the right size, glue the edge down smoothly, and let it dry, which will only take a few minutes. If you have used a sufficient length of paper, you will now have a perfectly round straight firm mandrel to work on. I may say that an ordinary round lead pencil will answer very well for starting the rolling up of the paper. Now cut a piece of nice smooth cartridge piper 9 inches wide, and long enough to go four times round the mandrel, which will take about 9 inches. Cut the sides of the paper perfectly square, and then roll it once round the mandrel and mark that distance by a pencil line, take it off the mandrel, and then with a brush full of hot, thin glue, go over all the rest of the paper up to the pencil line; *allow the glue a minute or so to soak in and the paper to stretch*, and then carefully roll it round the mandrel, rubbing it well down with the fingers, or with a small round stick (the lead pencil will do very well) as you roll it up. When it is all rolled up, roll it between your hands on the table, like a cook rolling out dough, and rub the joint well down, and also rub the pipe all over with the round stick. Slip it off the mandrel (there being no glue on the first turn cannot stick to it), and stand it up on end to dry, and it will be a tube 9 inches long, $\frac{11}{16}$ inch internal diameter perfectly straight and smooth inside and out. All this can be done in less time than it takes me to write the directions.

While the tube is drying, you may make the conical portion for the foot, this being formed of a piece of paper shaped as in Fig. 11, about 9 inches wide and 8 inches deep. Commence rolling it from the top corner as shown by the dotted lines in the sketch, and when

rolled up it will assume a conical shape of any diameter you may like to make it. Unroll it, give it a coat of thin glue, and *when it has had time to stretch*, roll it up again, rubbing it well down, inside and out, with a pointed stick to make each layer adhere thoroughly. When this is completed you will have a conical tube like Fig. 3, running almost to a point at one end, and irregular at the top. The outside join should be a straight line right down the cone, not winding round it ; the paper can be cut so as to ensure this just before you finish rolling it up. When this is dry, both the tube and the cone must be painted or varnished inside.

Though it may seem rather a difficult job to paint the inside of so small a tube, it is, however, quickly and easily accomplished by tying a piece of sponge on to the end of a thin cane or wire, so that it forms a kind of mop that will just go into the pipe ; dip this in the paint and work it up and down the inside of the pipe two or three times, and the job is done in less than a tenth of the time it would. take with a brush, and securing a much smoother coat of paint. The cone may be painted with a smaller mop, or a fine brush.

The paint must be allowed to get thoroughly dry and then you may trim off the top and bottom of the pipe with a pair of small pointed scissors, and trim off the top of the cone in the same way till it is exactly the same diameter as the tube, then rub the ends of the pipe and the top of the cone perfectly level on a piece of glass-paper stretched over a block of wood covered with cork. Cut out a flat piece of mahogany or cedar $\frac{1}{10}$ inch thick to the shape shown in Fig. 4, the straight part being two-ninths of the circumference ; the top and bottom edge of this straight part should be slightly rounded off with fine glass-paper. This circular piece, which is called the languid, should just fit the bottom of the tube on which you may now lay it, and mark where the ends of the straight part come, then cut a three-cornered piece of that width, and about 1 inch long out of the tube immediately over it, as shown in Fig. 6. A similar piece must now be cut out of the front of the cone, but the gap must be slightly narrower, so that, when it is placed against the end of the tube, the front of the cone will project slightly beyond it, to allow for the windway.

A piece of thin mahogany, or cedar, shaped as in Fig. 5, is cut to fit on the top of the cone. Lay the tube on a piece of glass-paper so that the part where the piece is cut out lays flat on the paper, and rub it down level, and proceed in the same way with the cone. Cut out two pieces of wood like Figs. 7 and 8 ; the first piece is chamfered on the front to form the upper lip, and the other is just rounded off at the top edges to form the lower lip. Glue the languid on to the bottom of the tube, and the under languid on to the top of the cone ; when dry you may bind on the upper and lower lips in- their proper position with a piece of narrow tape. The height of the mouth is about a quarter of the diameter of the opening.

You may now place the cone and the pipe together in their proper position, leaving a narrow windway between the straight edge of the languid and the lower lip ; hold it in that position and blow gently through the pointed end of the cone, and you will be rewarded by a musical note. If the note is not quite satisfactory, the upper lip may want shifting a little higher or lower, or the lower lip may require a little shifting. The top of the lower lip should be level with the top of the languid, or but very slightly below it. The windway should be about wide enough for a piece of thin playing card to pass. On the front edge of the languid, fine nicks should be made in a slanting direction with a fine penknife : about twenty to the inch for this pipe—this is the voicing, full directions in regard to which will be found in the chapter on voicing and tuning. Mark on the pipe the height of the mouth, then take off the lips, glue them and bind them in their places with tape. Even in the matter of binding on, there is a right and a wrong way ; the proper way being to bind with both ends of the tape, so that it crosses down the centre of the lip, you will then get the edges of the lip parallel with the edge of the languid. This is a point to be gained, as, if it is not parallel, the note will be faulty, either squeaking or chiffing, as it is termed, before it speaks the proper note. If it is satisfactory you may now glue the foot on to the tube and stand it up, and when dry, rub down the sides of the lips and round the joint of the languids with glass-paper to make it look neat. Cut a piece of glazed dress-lining as in Fig. 12 (the marks show where it is to be cut to make it lay even on the

cone), and glue it round the joint of the pipe, to strengthen it. There may be a little piece of the pipe projecting on each side of the mouth, which should be taken off with a sharp penknife. This is the smallest pipe that will require ears, which are simply pieces of veneer shaped as at A, in Figs. 13, 14 and 15, and glued on to the pipe against the edges of the lips, so that no wind may be lost. They will want chamfering on the edge where they are glued to the pipe, to make them fit on ; this may be done with glass-paper.

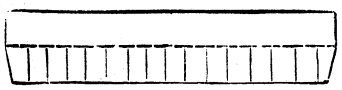

Fig. 12.–The Linen Band.

Cut off the bottom of the foot to the size required, about 6 inches will be long enough, and chamfer it off at the bottom about $\frac{1}{4}$ of an inch with a sharp knife. This chamfer has now to be coned in, just the same as metal pipes are, a metal cone being used for them ; but the amateur need not lay out 7*s*. 6*d*, in buying a metal cone, as a common china egg-cup, costing a penny, will answer the purpose equally as well. The under part of the foot will do to cone small pipes, and the cup itself will be used for large ones. You have merely to wet the chamfered part with your lips, place the foot of the egg-cup on it, and work it gently round with your hands till it is coned in sufficiently. The hole should come in the centre of the coning, and is about $\frac{1}{10}$ of an inch in diameter for this pipe ; it may be made quite round by inserting the point of a lead pencil with a slight screwing motion. When dry, the coning is quite hard, but the hole can be enlarged with the pencil, or closed with the coning cup, as may be required, to admit the proper amount of wind. Trim down the top of the pipe with the scissors until it speaks rather too sharp a note ; then make a short piece of tube about 1 inch long that will just fit on

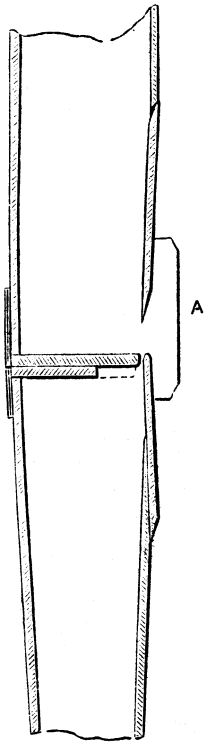

Fig. 13.–Section of Pipe (full size).

the pipe, and slide easily up and down. This is the tuning piece; raising it will flatten, and lowering it will sharpen the tone. The appearance of the pipe will be improved if you chamfer off the top edge, and also the top and bottom edges of the tuning cap. Give the pipe and slider two or three coats of oil paint to preserve it, and it will now be finished. The experience gained in making this pipe will be very useful, and you will very soon acquire the method of manipulation, so that you can go to work with certainty. Making a single pipe takes some time, as you have to wait about for the parts to dry, but when you commence on the sets of pipes required for the organ, you will find that no time need be lost.

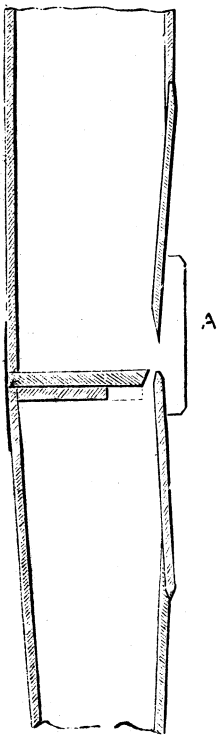

Fig. 14.–Section of Pipe with inverted mouth.

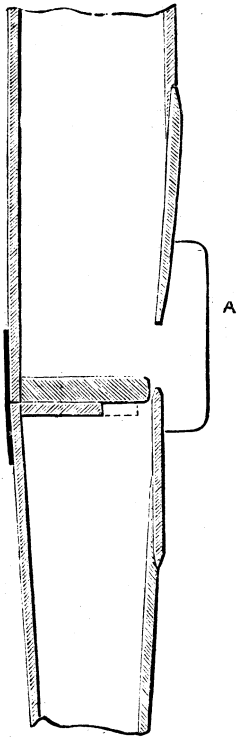

Fig. 15.–Section of Stopt Diapason shown in Fig. 16.

The first thing you will require to make will be several mandrels, say one for every fourth pipe; make them considerably longer than the pipe to be formed on them, for one mandrel may be used for more than one pipe. It is a maxim in organ building, that each stop should be of a different scale, but it will only be necessary to make one scale for these pipes, except the bourdon and the lowest octave of the stopt diapason.

The scale as it stands is for the open diapason, the stopt diapason treble will be one scale larger, that is the C of that stop will be made on the B mandrel of the open pipe, and so on. The flute, or principal, will be one scale smaller than the open diapason, the flageolet may be two scales smaller, while the keraulophon will be six scales smaller ; thus we may proceed with the tubes for all the pipes simultaneously. Having cut the sheets of paper to the necessary size, *allowing sufficient length in each pipe to cut off the tuning-pieces* —as the piece cut off one pipe will fit on to a smaller one and thus save having to make separate pieces— mark the distance of one turn round the mandrel by a pencil line on all of them, and mark them also with the name of the note of the pipe they are intended for. Suppose you start on 6 inch C, open diapason, you glue that sheet and lay it aside, glue another sheet for $6\frac{1}{2}$ inch B for the, flute, and another for $5\frac{3}{4}$ inch, Cs. stopt diapason. Now take up your first sheet and roll it round the mandrel, proceeding in the same way as with the experimental pipe ; when finished draw it off and stand it up to dry, roll up the second sheet, and slip that off, then proceed with the third. The reason for doing three sheets at a time is that it allows just sufficient time for the paper to stretch and the glue to get right for rolling up. You then glue three more sheets, viz., 7 inch As. flageolet, the 9 inch Fs. of the keraulophon, and one of the sheets for another mandrel, thus you can keep on making these tubes at the rate of twenty or thirty an hour when you get used to it, and have all the stops in hand simultaneously. Mark each pipe in ink with the name of the note and the stop it belongs to, so that you may be able to keep each stop separate. When you have made all the pipes you require on one mandrel, roll more paper round it and glue the edge down, to bring it up to the proper size of the next pipe, and so proceed till you have made all the tubes. Use cartridge paper for all pipes up to 2 feet long, using stouter paper for the larger ones, or else have five thicknesses instead of four. All pipes above 2 feet long should be made of stout brown paper, of which an excellent sort for our purpose is sold for laying under carpets ; it runs 4 feet 6 inches and someies 5 feet wide, and is continuous ; the price at all shops is 3s. per dozen yards, but at large, or wholesale shops, it may be pur-

chased much cheaper the 4-feet pipes should have five or six thicknesses and the larger bourdons seven or eight thicknesses. It will be more convenient if you make the large bourdons in two lengths, and then join them in the centre, covering the joint with a band of linen or thin American cloth, to strengthen it, or preferably gluing extra thickness or two of paper over the whole length of the pipe. The bourdon CCC is 8 feet long and $5\frac{3}{4}$ inches diameter, the smallest is 2 feet long and $1\frac{7}{8}$ inch diameter. The stopt diapason CC is to be $3\frac{1}{4}$ inch diameter, and tenor C $1\frac{3}{4}$ inch diameter. I apprehend that no difficulty will be experienced in setting out the scales for these similar to the scale previously made.

Having completed the tubes we may now proceed with the cones for the feet, and may use up the paper in the tube mandrels for that purpose. No mandrel will be required for the cones for pipes less than 1 inch diameter, as you can roll the paper up without being particular as to the size, for they are sure to fit some pipe, and can be cut off at either end to the requisite size. Six inches is long enough for all pipes up to 18 inches long, but for pipes above that length they should gradually increase till they are about 12 inches long for a 4-foot pipe. The length of foot makes no difference in the tone, so it is a mere matter of convenience and appearance. For the cones of the larger pipes you had better make two or three mandrels about 15 inches long and of different diameters. Make them in the same way as the cones, only, very much stouter. The cones should be stouter than the pipes as they have to bear all the weight, and are exposed to a good deal of wear. Having completed the cones you may next proceed to paint the inside of both them and the tubes, starting with the largest, as you can trim your sponge mop smaller so as to suit the smaller pipes. While the paint is drying you can prepare the other parts. The stoppers for the stopt diapason and bourdon pipes may be made of wood shaped as in Fig. 10, covered with leather round the lower edge, so as to fit tightly inside the pipe. I prefer to make a different style of covering or stopper as follows:—Make a short length of tube the same as for the sliding piece for tuning the open pipes, glue a piece of stout card on the top of this, thus forming a box or lid. Glue a strip of soft leather round the inside, having

previously pared down the edges of the leather; this cap is to fit tightly on the outside of the pipe like a lid. The leather should be rubbed with a mixture of tallow and black lead to make it slip easily, for it should not fit too tightly to be moved, as the pipe is tuned by moving it up or down. This cap is much lighter than the wood stopper, easier to make, and there is no danger of it slipping down, as Stoppers sometimes do when there is a sudden change in temperature. The caps should fit loosely on the Pipes at first so as to allow for three coats of paint on the pipe, when they should fit perfectly air-tight. As it is best to put the stopt pipes together with caps on, they may be temporarily fitted by wrapping two or three thicknesses of paper round the pipe.

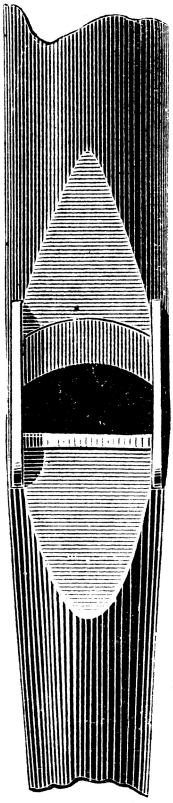

Fig. 16.–Front view of Stopt Diapason, showing Arched Upper Lip.

The caps of the stopt diapason should be 6 inches long for CC, and $\frac{1}{2}$ inch long for the smallest G. The tuning caps of the keraulophon are not closed at the top, they should be 6 inches long for tenor C, and $1\frac{1}{2}$ inches long for the smallest G. In the centre of the side of the cap, a distance of one diameter from the top, there is a round hole $\frac{3}{8}$ inch in diameter for tenor C pipe, and about $\frac{1}{16}$ inch for top G. The best way to make this hole is by a taper bit of such size that when it is bored through the cap so that the point just touches the further side of it, the hole in tenor C is $\frac{3}{8}$ inch in diameter, and as each cap gets smaller, the pushing the bit through so that it touches the further side, will cause the hole to diminish regularly. A sharp pointed stick will do instead of a bit, as the burr could be cleared off with a hot wire. The small scale high mouth, and the hole in the sliding cap of the keraulophon cause it to give a rich, though quiet, stringy tone, which is very useful in solo passages.

The flute and flageolet pipes are made with the upper lip turned so that the chamfer comes on the inside of the pipe, and the languid is sloped downwards on the front edge, as shown in Fig. 14. This causes it to give a soft quiet tone. The flute should be softer in tone than the diapason, and the flageolet should be softer than the flute. The stopt diapason is made with a high mouth, and the upper lip is cut slightly circular, the lower lip may be a little below the top edge of the languid.

The approximate lengths of the pipes from the mouth up to the top, and the sizes of the mouths for the several stops are as follows :—

	Width of Mouth.	Height of Mouth.	Approximate Length of Longest Pipe.	Approximate Length of Shortest Pipe.
Bourdon	One-fourth of the circumference	One-third of its width	8 ft	2 ft
Stopt Diapason	One-fourth	One-third	4 ft	$2\frac{1}{8}$ in.
Open Diapason	Two-ninths	One-fourth	4 ft	$4\frac{1}{4}$ in.
Keraulophon	One-fifth	One-third	4 ft	$4\frac{1}{4}$ in.
Flute	One-fifth	One-fifth	4 ft	$2\frac{1}{8}$ in.
Flageolet	One-fifth	One-sixth	2 ft	$1\frac{1}{16}$ in.

The sizes of the holes at the bottom of the coned feet are about as given hereunder, but the pressure of wind and the voicing affect the sizes considerably, and they may have to be a little larger or a little smaller according to circumstances.

	CCC.	CC.	Tenor C.	Middle C.	Top G.
Bourdon	$\frac{7}{8}$ in.	$\frac{5}{8}$ in.	$\frac{3}{8}$ in.	...	...
Stopt Diapason	...	$\frac{5}{8}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
Open Diapason	...	$\frac{1}{2}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
Keraulophon	...	$\frac{3}{8}$ in.	$\frac{5}{16}$ in.	$\frac{3}{16}$ in.	$\frac{1}{8}$ in.
Flute	...	$\frac{3}{8}$ in.	$\frac{5}{16}$ in.	$\frac{3}{16}$ in.	$\frac{1}{8}$ in.
Flageolet	...	$\frac{5}{16}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.	$\frac{1}{16}$ in.

The Lieblich Gedacht is simply a stopt diapason of the same scale as the principal, but with a straight upper lip, and the lower lip slightly below the upper edge of the languid. The languid increases in thickness with the size of the pipe, that of a 4 foot pipe should be $\frac{1}{4}$ inch thick. The same remark applies to the lips, which should increase in size and thickness with the size of the pipe. The upper

lip of the CC stopt diapason should be nearly $\frac{2}{8}$ inch thick at the thinnest edge. The lips can be expeditiously cut out of a piece of thin wood, by marking it out as shown in Fig. 17, and cutting though the marks with a tenon saw. The very best wood you can use for the languids and lips (except the smallest, which are simply veneer) is cigar-box wood. Cigar boxes can be purchased for twopence or threepence at most tobacconists or public houses, and many shopkeepers will give them away to their customers. The languids of the larger pipes may be fitted into the ends of the tubes instead of being simply glued on to them.

Fig. 17.–Method of Cutting out the Lips.

Having prepared a quantity of languids, lips, etc., glue them on, having previously cut out the portion of the tube and cone where lips come.

About a dozen pipes will be found a good umber to have in hand at one time for putting together.

The windway for the largest bourdon is nearly $\frac{1}{8}$ inch wide, for a CC stopt pipe $\frac{1}{16}$ inch wide, and gradually smaller for each succeeding pipe. Stopt pipes require a larger windway than Open pipes, as the mouths are cut higher and the upper lips are much thicker. The voicing nicks are nearly $\frac{1}{8}$ inch apart in a 4 foot pipe, but get closer and smaller as the pipe diminishes in size, until in the smallest pipes they are scarcely perceptible scratches very close together. They may be made with a very fine tuning file, or a small penknife. For a loud tone, the nicks should be few and deep, for a soft, sweet tone, they must be very fine and close together, the burrs being taken off by a slight touch with a piece of fine glass-paper. The upper chamfer should not be nicked. Wherever the wind passes there should be no sharp edges or it will cause a hissing noise, therefore, the top and bottom edges of the languid, the edges of the lower lip, and the front edge of the upper lip should be slightly rounded off but the inner edge of the top lip should be left square.

If it should happen that when a pipe is finished the windway is too narrow, it may generally be set right by passing the thin blade of a penknife flat down between the lip and the edge of the languid, but if this is not sufficient, cut a slip of fine glass-paper and insert that, moving it gently up and down, so as to take a very little off either the edge of the languid or the inner edge of the lip, whichever may be required, and then carefully touch up the voicing. For cutting the lips a little higher, and touching up the pipes generally, you will find the following tool very handy, and should make five or six of different sizes :—a thin slip of wood, or veneer, say 1 inch wide at one end, and ½ inch wide at the other, covered on one side with very fine glass-paper and on the other with some a little coarser. You will thus have four files in one. Another handy little appliance is shown at Fig. 18 ; it is a block of wood, 5 or 6 inches long, 3 inches wide, and 1½ inches thick, covered on the bottom with a flat piece of cork. A piece of glass-paper can be stretched over this, and grasped in the hand, and may then be used to smooth off the ends of the pipes, the edges of the lips, and any small chamfering. You will have this block in requisition at all stages of the work.

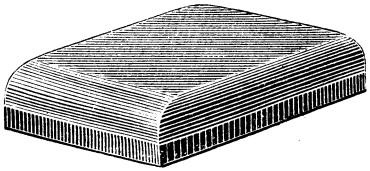

Fig. 18.–Block covered with Cork for using with Glass Paper.

The pipes, caps, and tuning pieces, should have three coats of oil colour, a little varnish being mixed with the last coat, and it will be found a good plan to paint each stop a different colour, as any stop can then be picked out at once.

Write the name of the note, and the stop, on the back of each pipe, using ordinary ink and a Waverley or Pickwick pen, as the points will not scratch the paint. Breathe on the place and pass the finger over it, the ink will then flow as nicely as on writing paper.

The painting or varnishing of the pipes preserves them from the damp, and improves both their tone and appearance.

The following points should be strictly adhered to, viz., all pipes above 12 inches long should be allowed to dry on the mandrel, or they may be apt to cast a little, which will not improve their appearance ; the foot to be perfectly straight with the pipe, the lips to be quite parallel with the edge of the languid and with each other, the nicks for the voicing to be even and regular, and the caps of the stopt pipes to fit perfectly air-tight.

CHAPTER II.

WOOD PIPES.

I NOW proceed to describe the process for making wood pipes—so that the amateur may be able to place them in his organ for use either by themselves or in conjunction with the paper pipes described in the previous chapter. I would remark, however, that every variety of tone required may be obtained from the paper pipes, whilst the wood pipes afford but a limited range of tone. The Keraulophon stop, for instance, cannot well be made of wood, but is very successful in paper.

As with the other pipes, we shall, of course, require a scale to work from, only it will be necessary to set out a fresh one for each stop. Draw the line on a board 4 feet 6 inches long, and divide it out exactly as described in the last chapter, but as wood pipes are not round but oblong in plan, two diameters are required for each pipe, instead of only one as in round pipes. The size of the largest stopt diapason is $3\frac{1}{2}$ inches deep by $2\frac{5}{8}$ inches wide, so you set off those distances on the topmost cross-line, and draw the sloping lines from them down to the point 6 inches below the mouth, as shown in the sketch, Fig. 19. By measuring in just the same way as before described, you will be able to obtain the length, width, and depth of each pipe. I have only shown the largest octave on the sketch, as I think you will have no difficulty now in making a scale for any sized stop you may wish for.

The six largest pipes of the stopt diapason will be made of $\frac{3}{4}$ inch pine, and the others will be graduated in thickness till the smallest is only $\frac{3}{16}$ inch thick. You need only take the roughness off the side of the wood which is to form the outside of the pipe, for it is best to plane them up when you have put them all together, as you can make them look nice, and also graduate the thickness of the wood in

regular proportion to the size of the pipe. Let all the wood be of the best quality and free from knots or shakes, as knots are almost sure to loosen some time or other and thus spoil your work, perhaps when you are least able to remedy it. Keep your wood by you as long as possible before using it, so as to ensure its being thoroughly well seasoned. First prepare some wood for the blocks of your pipes, by planing up some lengths of pine about 2 feet long, and gluing a piece of $\frac{3}{8}$ inch mahogany on one side of them. The scantlings of these pieces will be indicated by the diameters of the pipes for which they are to form the blocks. Plane the first piece down to the size required for the largest pipe, viz., $3\frac{1}{2}$ inches by $2\frac{5}{8}$ inches, the mahogany facing being on one of the narrow sides, and cut off a piece 4 inches long ; dress the remainder down to the size of the next pipe, but do not touch the mahogany side again, and cut off 4 inches for that one ; dress the remainder down for the next sized block, and cut that off, and so keep on till you have cut off all your blocks. The first twelve will be 4 inches long, the next twelve 3 inches, the next $2\frac{1}{2}$ inches, the rest about 2 inches, and these proportions may be used for all the pipes in each stop, as the length of the block is not a very material point provided it is long enough. Now shape the block as shown in Fig. 20, by cutting a gap with a tenon saw through the mahogany facing into the block, keeping the same proportions for each block, and using a chisel to take out the piece. The sloping part should be cut up to within about $\frac{1}{4}$ inch of the top edge, but be extremely careful not to damage the edge. The opening shown in the bottom is a round hole, which will be bored after the pipe is put together, and the foot will be inserted in it. When you have got a dozen or so of these blocks ready, get out the wood for the sides of the pipes, remembering that the sides are the deepest measurement of the block, and also that the sides and backs must be long enough to come down to the bottom of the block as the scale length does not include this. After planing them true give them all a coat of very thin hot glue on the inside, to stop all the pores, and, when dry, glue the block in between them as shown in Fig. 21. It will be well to preserve the pieces you cut out of the blocks, and glue them between the sides at the top of the pipe, and you will thus have them quite

parallel. The pieces glued at the top will be cut out when trimming down. If you cannot get these pieces out of the blocks without breaking them up, you must cut a slip the same width and use that when gluing up the pipes. While this is drying prepare the backs, treating them with thin glue the same as the sides, and then glue them on to the sides. It will be well to allow both the backs and fronts to lap over about $\frac{1}{8}$ inch on each side, so that the dents made when you bind the pipes up with strong tape or string to secure the glue joints may be no detriment, as they can be planed off afterwards.

Now prepare the fronts—which only extend down to the top of the block—2nd cut the chamfer for the upper lip, and the opening for the mouth, as shown in Fig. 33. It is a very good rule to cut the chamfer as high as it is wide, but the lips had better not be cut too high nor too thin at first, as the height of the mouth will have to be regulated when you are engaged in voicing and tuning, instructions for which will be given in a subsequent chapter. All dimensions for the heights of the mouths, the widths of the windways, the holes in the blocks and feet—in fact, every size except the diameters of the pipes, will be the same for the respective stops as those given in the last chapter for the paper pipes, so there will be no need for me to recapitulate them here. The sizes given for the holes in the feet of the smaller pipes in page 17 must be considered as only approximately correct, as they may require to be coned in much smaller in some instances. In the wood pipes it is especially necessary that the hole should be large enough to allow plenty of wind to pass. If it should be too large, a small wood plug is inserted at the bottom to stop off a little of the wind, but it would be awkward to remedy if the hole was too small, as it would entail the enlargement of it right through the length of the foot. You will find the small American planes, which are made of iron, very useful for smoothing the chamfers, etc.

Before gluing on the fronts or backs be sure that they will lay perfectly flat on the edges of the sides, and in order to secure this it is best to shoot the edges with the plane after the blocks are glued in. The front and back surfaces of the blocks should coincide with the

lines of the front and back edges of the sides. Glue on the fronts, and bind them up tightly with stout ape or string, and then leave them to dry while you prepare the caps. These caps are the pieces of wood which cover the gaps in the front of the blocks. All the caps should be made of mahogany, those for the stopt diapason being simply flat pieces the same thickness as the fronts of the pipes. The windway in the block (on the top front edge) should be made with a flat file ; do not make it too deep, but leave the final touching up for the time when you are tuning. You may now with a centre-bit bore the holes in the centre of the bottom of the blocks to receive the feet, which are simply round pieces of wood about 6 inches long, with a hole through them of the size required. They can be purchased ready made at a very cheap rate, but if you have a lathe they may be made at home.

Next prepare the stoppers, or tompions, which are shaped as in Fig. 23, and covered with soft sheepskin, so that they will just fit into the top of the pipes so as to close them in quite air-tight. The stoppers must not, however, fit so tightly as to prevent their being moved up and down. The leather is to be glued on the grained side, and this must be first well rubbed over with glass-paper to take off all the smoothness, or the glue will not hold. A mixture of tallow and black-lead should be rubbed on to the outside of the leather when the stoppers are completed, and they will then slip up and down easily, but be sure that they are perfectly airtight. Let no one persuade you to make stoppers of a piece of board with a handle stuck in the middle, as in consequence of the bearing surface being so small they slip askew and force the seams of the pipes open, thus ruining them. The stoppers should have, at least, 2 inches in depth of bearing surface. I may say that brads may be used in addition to glue for putting the larger pipes together, but be careful not to drive any nails into the blocks or you will ruin your bits when boring the holes for the feet. The feet should not be glued in till it is time to plant them in their places, as you will then be able to regulate them so as to ensure the pipes being upright. File no notches on the edges of the blocks, but leave them quite smooth.

The bourdon is simply a stopt diapason, and is made in exactly the same way. The largest pipes may, if you like, be made with languids instead of a solid block, by cutting two pieces of wood, and fitting them into the pipe as shown in Fig. 25, and they may be secured with glue, and small brads. The largest pipe CCC, which may be made of 1-inch pine, is 8 feet long, $5\frac{3}{4}$ inches deep, and $4\frac{5}{8}$ inches wide; the smallest is two feet long, $2\frac{3}{8}$ inches deep, and 2 inches wide. The bourdons should also be furnished with ears as shown at E in Fig. 25. You must not be disappointed with the bourdons if they do not appear to sound very loud. Close to the organ a mere rush of wind might be heard, but some distance away the sound would be overpowering, in the next house, or two or three houses off, it would, most likely, be voted a nuisance. I may state, however, in order to prevent misapprehension, that it is not advisable to have a separate pedal organ for a room less than 16 feet square. An additional bass stop on the manual, to be used in lieu of a 16-feet pedal stop, will be described in the next chapter.

The Lieblich Gedacht (German, lovely stopped pipe) is simply a stopt diapason of the same scale as the open diapason. The block is cut out as shown in Fig. 26, and the mahogany facing projects $\frac{3}{4}$ inch above it for CC, and about $\frac{1}{8}$ inch for the smallest. This stop is described to be used in the swell organ of the two-manual instrument, but it may be substituted for the stopt diapason of the single manual from tenor C upwards. The stoppers are made in the same way as for the stopt diapason. The cap is hollowed out, as shown at c in Fig. 26, and Fig. 30 is an inside view of a similar cap. The top of the cap should be slightly below the edge of the mahogany facing, about $\frac{1}{8}$ inch in the largest and $\frac{1}{24}$ inch in the smallest.

We now come to the open diapason, which is the chief stop in the instrument, but in our small instrument it is only carried down to tenor C, which, however, being an open pipe, is 4 feet long, the same as the CC stopt pipe; the width of it is $2\frac{1}{2}$ inches and the depth $2\frac{3}{4}$ inches. It has a straight block with merely a throat cut in it, as shown in Fig. 27; the cap c is cut out as there shown, and another view of it is given in Fig. 32. The upper part of this hollow should

not be made with the chisel, but with a flat file as it is very easy to make too deep a windway, and then you would have to reduce the thickness of the cap by rubbing it on glass-paper in order to remedy the defect. All hollow caps should be slightly thicker than the fronts of the pipes, and project below the block so as to allow of screwing them on without splitting them. Three, or at most four, small screws to each cap are all that should be required, and the cap should fit so nicely that no wind can escape except through the windway.

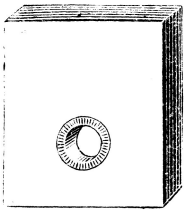

Fig. 29.–Front View of Inner Cap.

We next come to the flutes top, which is made in a rather different manner, as it has what is termed an inverted mouth, that is the chamfered side of the lip is turned to the inside of the pipe so that the front would appear quite plain all the way down, with merely the mouth cut in it. You must not plane the front of this stop after it is put together, or you will spoil it, all planing for the front must be done before it is glued on. This pipe will require two caps, the inner one being merely a flat piece of mahogany, as in Fig. 29, the exact thickness of the front of the pipe, and having a round hole bored opposite to the throat, and countersunk on the outside. This cap projects above the edge of the block exactly the same height as does the mahogany facing in the Lieblich Gedacht. The outer cap is also hollowed out exactly in the same way as for that stop, but should be level with the top edge of the inner cap. The scale for CC is $2\frac{1}{2}$ inches deep and $2\frac{1}{4}$ inches wide.

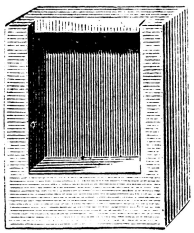

Fig. 30.–View of Inside of Outer Cap of Flute.

Another stop, which may be made of paper or wood, and is called the Gemshorn (German, goat's horn) may be substituted for the flute. It gives a beautiful, slightly stringy tone, not quite so powerful as the flute, but more penetrating, and is much used in small organs as a substitute for the principal. It is conical in shape, the diameter at the mouth being the same as in the flute, but at the top it is only one-third of that diameter. Of course it is rather more

trouble to make than the straight pipes on account of the necessity of preserving the proper proportions. If made in paper, one mandrel for every three pipes will be all that is necessary as you can cut the pipes down at either end to get them to the proper size, and you would make them in much the same way as you make the conical feet, only taking care to have the inside join in a straight line down the pipe. The mouth is cut up one-third of its diameter, and, if made of wood, the block and cap may be like either the flute or open diapason, which ever you may desire (see Fig. 34).

The keraulophon, as I have already stated, should not be made of wood.

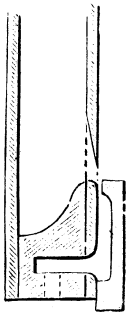

Fig. 31.–Section of Lower Part of Flageolet.

The flageolet stop is made with a block shaped as in Fig. 31, and has an inverted mouth like the flute. The largest pipe is only 2 feet long and the scale is $1\frac{3}{8}$ inch deep by $1\frac{3}{16}$ inch wide. This stop will need great care in making as the pipes run so very small in the treble, and you must be very careful not to let it be too loud and shrill. If you can possibly afford it, make these pipes entirely of cedar or mahogany. The holes through the feet are very small, so the best way will be to glue a disc of thin mahogany on the bottom of the foot so as to close it up entirely, and then drill a very fine hole through it. This, of course, applies only to the pipes of the smaller octaves.

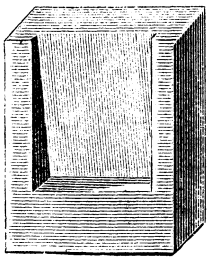

Fig. 32.–View of Inside Cap for Open Diapason.

The thickness of the wood will be nearly the same for the same sized pipes of any stop, but you may allow stopt pipes to run thicker than open ones, as they give a note a octave lower. The rule is that the thicker the wood the fuller and rounder is the tone. Open pipes are tuned by a lid of soft tin or zinc which is bent down and let into a saw cut made in the thickness of the back of the pipe. This lid should be rather larger than the top of the pipe, but should never be shut right down ; raising it sharpens and closing it lowers the tone.

Fig. 33.–Open Diapason

The pipes are all to be made according to the lengths given in the scale, with the addition of the length of the block. They will all be slightly longer than the tone speaking length, but this is necessary in order to allow for the stoppers in the stopt pipes, and for cutting down to the right note in the open pipes. The same remarks apply to the scale lengths of the other pipes. When trimming the pipes down only very narrow pieces should be taken off with the tenon saw, for you can always take off more if required, but it becomes an awkward matter to remedy if you cut the pipe too short. The scales of all the pipes described are small scales, suitable for chamber organs. For a church organ the scales would be much larger.

The lips of the large bourdons may be made of mahogany and tongued on to the fronts, as shown in Fig. 25, which is to a scale of $1\frac{1}{2}$ inches to the foot.

All the *sections* in this chapter, with the exception of Fig. 25, are to a scale of 3 inches to the foot, or one quarter of the full size. They represent the largest pipe in each stop. The sizes of the throats in the blocks and the sinkings in the caps may be taken from these sections, and should be gradually lessened for each successive pipe, preserving about, the same proportions to the size of the block. It is, however, not requisite that the dimensions of the throat should be set out with mathematical nicety.

The pipes, when completed, should be carefully packed away in a dry place in a room where the temperature is about the same as that in which the organ will be built. It is best to complete all the pipes, if possible, before commencing on any other portion of the instrument, as it gives them time to season and settle down, and should there be any defects in the joints they will have time to demonstrate their existence. It is very annoying to find out these defects after you

have got the organ into working order, and thus have to leave other work to remedy the mischief. As regards painting the pipes, some persons advocate plain wood, for the excellent reason that the paint is often used to hide bad materials and worse workmanship. This, however, is no reason why paint should not be used on material and workmanship known to be good, and my own experience justifies me in saying that it improves the tone in many cases, and undoubtedly preserves the material, whilst it looks better than plain wood for pipes that are in sight.

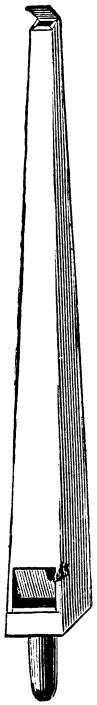

Fig. 34.—Gemshorn.

In the concluding chapter will be found a few specifications for organs of a larger size, so that amateurs who have plenty of time and money at their disposal, may gratify their wish to possess the best instrument within their reach.

In the meantime I would urge the would-be organ-builder, before starting on the work, to consider the size of the apartment in which the instrument is to be placed, so that the organ may be suited to the surroundings. It must be remembered that, though a single pipe does not sound very loud, a full chord on one stop gives a considerable increase in tone, and when all the stops are out and the couplers in action, the noise would be simply unbearable unless great care were exercised to keep down the power of the pipes when in course of construction. For this reason I advocate pipes of small scale, with the mouths not cut too high, as they can be made to speak up well and yet not he noisy.

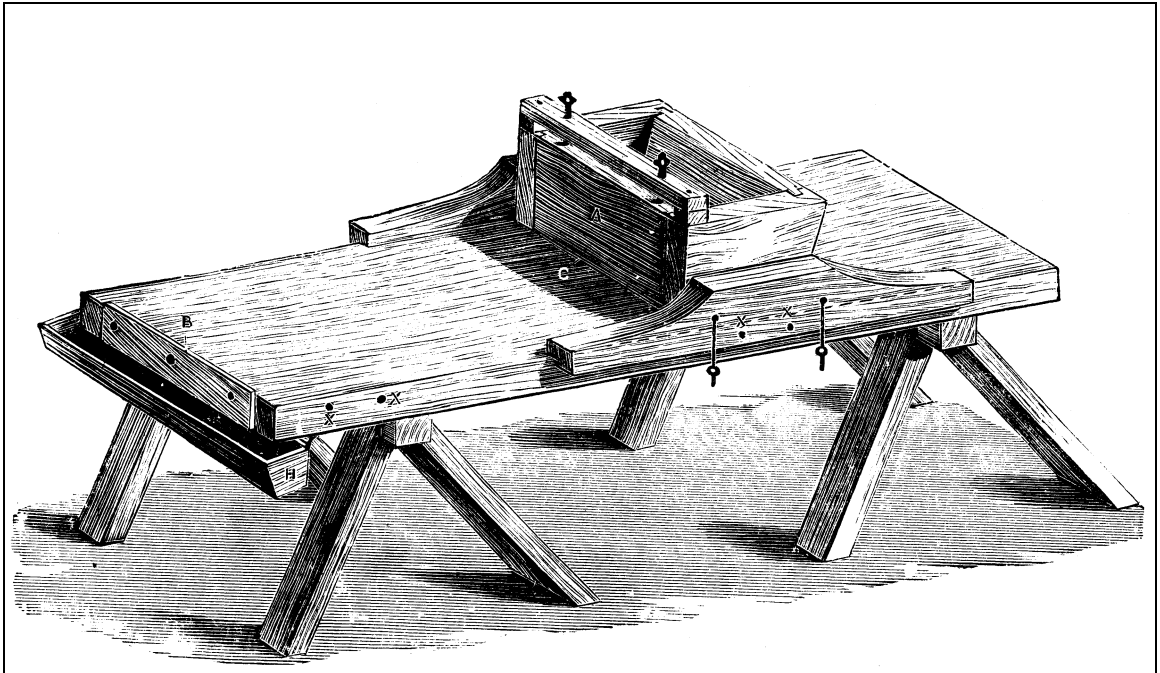

Fig. 35.—View of Casting Bench and Casting Box.

CHAPTER III

PIPES OF METAL—CASTING BENCH AND CASTING BOX—METAL FOR PIPES—MELTING METAL—NECESSARY TOOLS—SCALE FOR CUTTING METAL FOR PIPES—FORMATION OF SHEET METAL INTO PIPES.

IN giving instructions respecting metal pipe making I may say that I have generally rather deprecated amateur attempts in this branch of organ construction, for two reasons, viz. (1), because it is undoubtedly a fact that but very few amateurs possess the requisite skill; and (2), because in most cases metal pipes could be bought at a less cost—when the outlay for tools and apparatus is taken into account—than that which would be incurred by an amateur in making them for himself. But, as it is quite true that amateurs have before now turned out very creditable work in this branch, I will now endeavour to describe, in as clear and concise a form as possible, the modus operandi, for the benefit of those who may be ambitious of trying their hand at this rather difficult work.

If amateurs intend to cast their own pipe metal, it will be necessary that they should have a proper bench, for which purpose many manufacturers use a large slab of York stone or slate, whilst others have a wooden bench.

As this latter form will probably be that most within the reach and requirements of the amateur, I will describe it more particularly. The top or table of the bench is formed by placing pieces of stout wood—yellow deal will do—about $\frac{1}{8}$ inch apart, and then bolting them tightly up, but keeping them apart by pieces of thin stuff. If you, do not propose to cast metal for pipes larger than tenor C open diapason, the bench top will require to be about 5 feet long and 18 or 20 inches wide, and should be formed of deals $1\frac{1}{2}$ inch thick and about $4\frac{1}{2}$ inches wide, placed *edgewise*, $\frac{1}{8}$ inch apart, and bolted up in the manner described. The planks should run lengthways of the

bench. True up both top and under side of this table, and square it at each edge. The bench or table top is now to be covered with a piece of good linen, bed-tick or moleskin cloth. This should be stretched tightly over the top, brought down all round, and then securely tacked on the under side of the bench. See that this work is well done, and that the ticking or moleskin lays perfectly smooth and without wrinkles, and be careful that there are no chips between the table and the ticking, or anything that would cause the slightest deviation from a level surface. The table-top should now present an appearance similar to that of an artist's canvas stretched ready to paint upon. The bench is then placed upon a pair of trestles, or otherwise firmly supported, so that it lies quite level.

The casting box is a simple affair, but it must be strongly put together. Fig. 35 shows both the bench and the casting box, and it will be seen that the latter is a square box with a sloping back, and is nearly as long as the bench is wide. It should be made of oak at least 2 inches thick, and may be 5 or 6 inches wide at the top, and about 5 inches high. It has no bottom, and the front is made to slide up and down a little way. This may be managed by cutting a tenon on each end of the front, and carefully fitting it into a groove at each end of the box. A strip of inch oak is fixed to the ends, so that it is raised about $\frac{1}{2}$ inch above the front, and a couple of fine threaded thumb-screws, or screws with fly nuts, are then screwed through the slips into the top of the front, so that by turning them the front may be raised or lowered, so as to regulate the width of the opening marked C in Fig. 35 at the bottom, through which the metal will flow when casting. The bottom edges of the box must be planed perfectly true, so that no metal can run out except at the proper opening. A rebated runner is fixed on each end of the box, so that the rebates just fit over the edges of the bench, and allow the box to be pushed freely backwards and forwards along the top of the bench. Now screw a slip of brass along the front end of the bench, as shown at B, bring the casting box close up to it, so that the brass securely closes the opening at the bottom, and with a bradawl bore a couple of holes through each runner into the bench side; about an inch will be sufficient. If a stout wire is inserted in each of these holes, the box